Photovoltaics in Heritage Buildings

An Introduction for Architects

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FuturHist

ABOUT THIS LEAFLET

The information in this leaflet is part of the research project *FuturHist – An integrated typology-based approach to guide the future development of European historic buildings towards a clean energy transition.*

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Welcome!

Retrofitting our cultural heritage buildings isn't just about preserving the past – it's about preparing for the future.

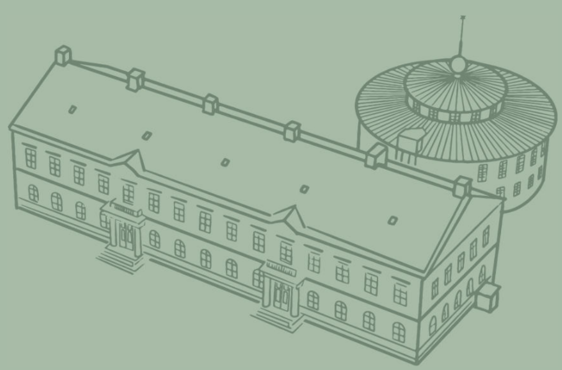
The FuturHist international research project explores new ways to increase the energy efficiency of heritage buildings, retrofitting existing buildings in a way that respects their historic values.

As a part of that work, we have produced this leaflet which aims to support architects working with historic buildings who want to integrate solar energy.

Through concrete examples, this leaflet will give you an introduction to the process, challenges and strategies of using photovoltaics in a historic context.

We hope that this material will inspire you to work with photovoltaics in future heritage projects.

Sincerely,
The FuturHist team



Overview Installing Solar Panels on or Near a Historic Building

When adding solar panels to a listed or historic building, it is important to look beyond the main roof. Suitable locations may also exist in the surrounding grounds (the curtilage) or nearby, where the impact on heritage values may be lower. The process below helps ensure that solar installations respect historic character while supporting sustainability goals.

1 Start the Project

▶ Define the building and its surrounding area.
▶ Agree on energy and sustainability goals with the client.
▶ Bring together the right team, including heritage and technical specialists.

2 Understand the Heritage Value

▶ Review listing documents and planning history.
▶ Identify important features, materials, views and settings that must be protected.

3 Assess the site

▶ Identify roofs, walls or ground areas with good sunlight.
▶ Check structure, orientation, shading, electrical capacity and building condition.
▶ Look for less sensitive areas within the site.

4 Develop and Compare Options

▶ Test different locations and panel types.
▶ Compare visual impact, technical performance and cost.
▶ Use drawings and visualisations to assess how proposals will look.

5 Assess Heritage Impact

▶ Evaluate how the proposal affects the building's significance.
▶ Consider both direct and indirect impacts.
▶ Adjust positioning, materials or detailing to reduce harm.

6 Engage Stakeholders

▶ Consult relevant stakeholders and revise proposals based on feedback.
▶ If no acceptable solution is found, consider installing PV on new extensions or secondary structures.

7 Planning and Consent

▶ Prepare and submit the required planning and listed building applications.
▶ Include heritage assessments and visual material.
▶ Revise proposals if required.

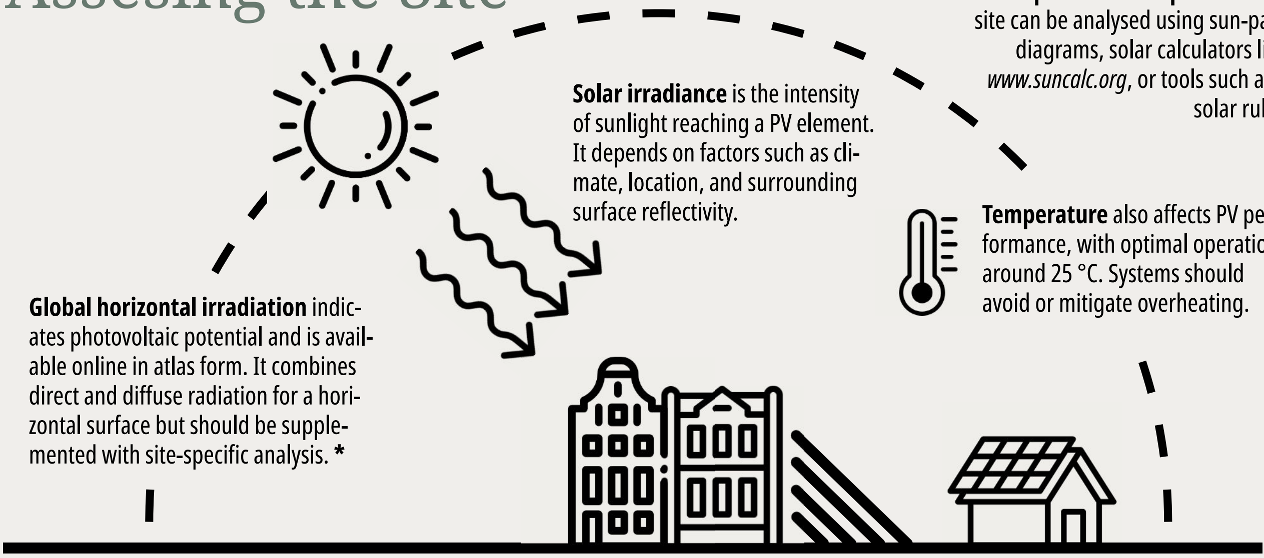
8 Detailed Design and Installation

▶ Finalise products and fixing methods (preferably reversible and non-invasive).
▶ Supervise installation to avoid damage to historic fabric. Record for heritage documentation.

9 Monitor and Maintain

▶ Monitor energy performance and visual impact.
▶ Plan for regular maintenance.
▶ Record lessons learned for future projects.

Assesing the Site



Sun positions and paths for the site can be analysed using sun-path diagrams, solar calculators like *www.suncalc.org*, or tools such as a solar ruler.

Solar irradiance is the intensity of sunlight reaching a PV element. It depends on factors such as climate, location, and surrounding surface reflectivity.

Temperature also affects PV performance, with optimal operation around 25 °C. Systems should avoid or mitigate overheating.

Global horizontal irradiation indicates photovoltaic potential and is available online in atlas form. It combines direct and diffuse radiation for a horizontal surface but should be supplemented with site-specific analysis. *

Shading significantly reduces PV performance; partial shading can cause overheating, material stress, microcracking, and eventual damage.

Slopes and orientations that maximise direct solar incidence are best for PV, with optimal angles varying by geographic location.

***** Scan the QR-code to reach the tool at *https://joint-research-centre.ec.europa.eu/photovoltaic-geographical-information-system-pvgis_en*

Assessing the Heritage Impact

Heritage Impact Assessments (HIAs) are increasingly required across Europe to manage change within the historic environment. While UNESCO and ICOMOS provide the international foundation, national authorities apply and adapt these principles in varied legal and cultural contexts. Four aspects of the design proposal are typically assessed.

Material impact

The extent to which the physical interventions introduced during a retrofit alter the historic building's existing fabric or its setting — and how this affects the heritage significance of the building and its settings.

Visual impact

The extent of visual alterations to the building and its setting, both internally and externally, such as changes in color, style, or the addition of new visual elements that affect its character — and how this affects the heritage significance of the building and its settings.

Reversibility

The potential of retrofit measures (materials, components, or alterations) to be removed, dismantled, or reversed without causing physical damage to the historic building's structure, finishes, or setting. Note: inappropriate retrofit interventions that would undermine the heritage significance of the building, even if they are reversible, should be discarded. Where there are options, compare their relative impacts.

Spatial impact

Spatial impact evaluates how the retrofit intervention alters the building's interior layout, volume, or external footprint, affecting its historic function, spatial experience, and relationship with its surroundings — and how this affects the heritage significance of the building and its settings.

Designing with Photovoltaics
The Four Intervention Types

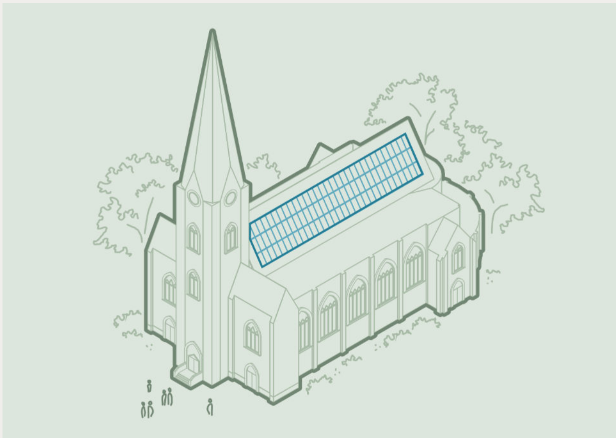
Integrating solar panels into historic environments can be done in many different ways, depending on the specifics of the building and site. We have defined four main strategies for solar interventions: **Addition, Replacement, Extension/ Completion** and **Independent**. Examples of these strategies can be found on the following pages.

Addition (Building-Applied Photovoltaics)

Building-Applied Photovoltaics (BAPV) refers to PV systems installed as an additional layer on top of existing building structures, such as roofs or façades. These systems are mounted over pre-existing surfaces and typically remain visually distinguishable from the underlying architecture, although they can be integrated to varying degrees – for example through colour matching.

Where the original roof covering is considered worthy of preservation or sensitive to alteration, this approach may be preferable.

Considerations:
▶ Evaluate whether the existing building fabric can accommodate a surface-mounted PV system without unacceptable alteration or damage.
▶ Assess the degree to which the added PV layer will remain visible and how this may affect the character and appearance of the building.
▶ Engage with local planning and heritage officers early to establish whether a building-applied approach is appropriate for the site.

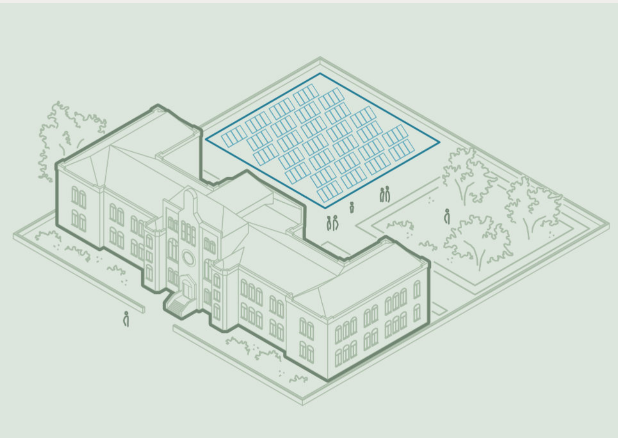


Replacement (Building-Integrated Photovoltaics)

Building-Integrated Photovoltaics (BIPV) are embedded directly into the building envelope, replacing conventional materials such as roof tiles, sheet metal, or façade cladding. This approach allows for a more seamless and less visually intrusive integration, which can be particularly relevant in heritage contexts. Although BIPV systems may involve higher initial costs, these can be partially offset during major refurbishments by reducing the need for conventional roofing or cladding materials. BIPV solutions are often well suited to projects where conservation requirements, planning considerations, and visual integrity are important.

Considerations:
▶ Determine whether replacing existing roof or façade materials would affect elements that contribute to the building's heritage significance.
▶ Consider the visual compatibility in terms of colour, texture, reflectivity, and module layout.
▶ Discuss the proposal with local planning and heritage officers at an early stage, particularly where listed fabric or prominent elevations are involved.

For an overview of PV products, you can look at the Eurac repository by scanning the QR-code or visiting *https://ipvprojects.eurac.edu/en/products.html*

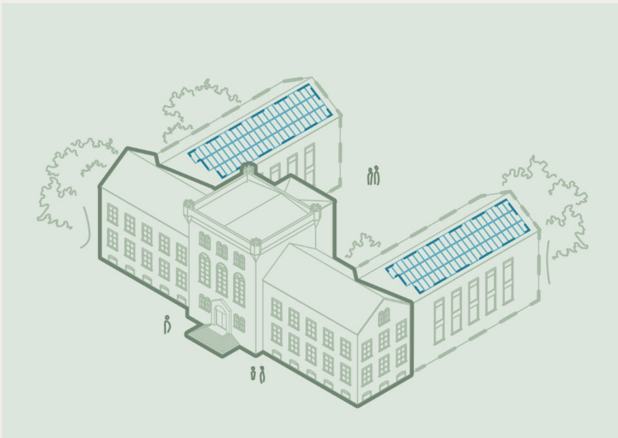


Independent (within the curtilage or nearby)

The use of PV technology may be more acceptable when located within the curtilage of a heritage site rather than on the main structure itself. Where space permits, this can include freestanding installations such as ground-mounted PV arrays or systems mounted on independent structures, for example a garden pergola or carport.

Installing PV in nearby locations that are less sensitive to change than the principal building may therefore be a suitable alternative. When carefully designed, such interventions can reduce potential impacts on heritage significance while remaining compatible with conservation area or listing requirements.

Considerations:
▶ Confirm the heritage designation of any ancillary buildings, as structures within the curtilage may carry the same level of protection as the main building.
▶ Evaluate the visual impact of PV installations on the setting and character of the principal heritage asset.
▶ Engage with local planning and heritage officers early in the design process.



Extension/Completion (of existing structure)

Where new extensions or substantial alterations to parts of a building are planned – or have already been carried out – these newer elements may offer suitable opportunities to accommodate BIPV or BAPV systems.

Such solutions can often be integrated more readily into contemporary additions, provided they are designed sensitively and comply with relevant planning, conservation area, or heritage requirements.

Considerations:
▶ Assess whether the extension or altered part of the building is of later date and lower heritage significance than the principal structure.
▶ Ensure that the integration of PV supports the architectural character and detailing of the new or modified element.
▶ Consult local planning and heritage officers early to confirm acceptability in relation to the wider heritage asset.

Addition
King's College Chapel

University of Cambridge, UK | Architect: Caroe architecture with Max Fordham

Background
King's College Chapel in Cambridge – a Grade I-listed Gothic landmark built between 1446 and 1515 – required renovation of its 1950s lead roof, which was no longer watertight. As one of the UK's most significant historic buildings, any intervention required great care. The roof replacement created a rare opportunity to consider renewable energy generation on the College's main site.

Solution
As part of the roof renovation, 438 reversible solar panels were installed on top of the refurbished lead roof. As the panels are hidden from view, the use of building applied photovoltaics was chosen. The panels are mounted on an independent frame system to protect the historic fabric. Together, they can generate approximately 123,000 kWh of electricity per year, with a peak output of 100 kWp.

Replacement House Breuer

Schruns/Tschagguns, Austria | Architect: Bernhard Breuer

Background
The historic Alpine barn in Tschagguns, Austria, was converted into a modern residence while preserving its original wooden exterior. Because the building offered a large, south east–oriented roof surface with a 35° pitch, it was well suited for renewable energy integration. The renovation aimed to maintain the barn's traditional appearance while enabling high energy autonomy.

Solution
The photovoltaic system covers about 55 m^2 generating roughly 200% of the building's annual electricity demand. Visually aligned with the opposite copper clad roof, it maintains the barn's traditional appearance while working alongside integrated solar thermal collectors to support hot water and heating. The result is near energy self sufficiency, significantly reduced electricity costs, and a discreet integration.

Independent
Chippenham Hall

Cambridgeshire, UK

Background
Chippenham Hall is a Grade II listed stately home set within a Grade II registered park and garden in east Cambridgeshire. Built around 1886 on the site of earlier 17th- and 18th-century houses, the estate has evolved over centuries and holds significant architectural and historic value. The owners sought to reduce rising electricity costs, but any intervention within the protected historic landscape required careful consideration to avoid physical or visual harm.

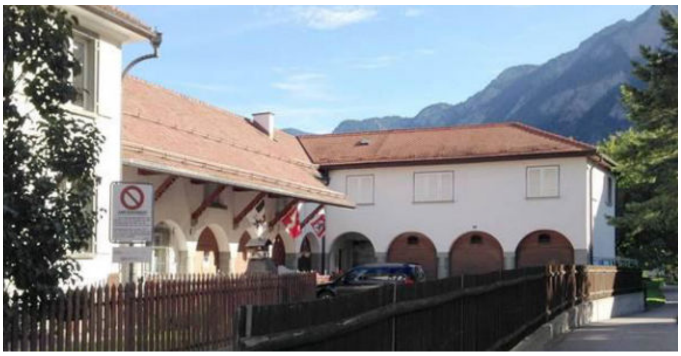
Solution
A ground-mounted photovoltaic array of 32 solar panels was installed independently of the main Hall, occupying approximately 0.025 hectares within the historic gardens. The panels are discreetly sited and screened by sensitively planted hedgerows, ensuring minimal visual and physical impact. The installation now supplies renewable energy to the estate while preserving the character of the listed park and garden.

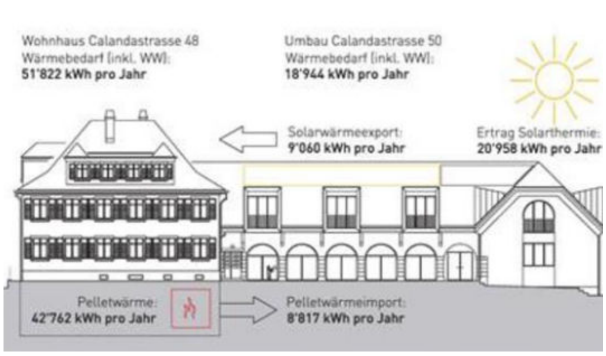
Extension/Completion
Kindergarten and apartments

Chur, Switzerland | Architect: Pfleger + Stöckli Architektur (Original building by Schäfer + Risch)

Background
Built in 1914, the buildings form an architecturally coherent Heimatstil ensemble in Chur. Although not protected, the City of Chur as owner and client set out to make the refurbishment a model for integrating energy efficiency and on-site energy production. The challenge was to upgrade performance to near zero-energy standards while preserving the historic character, restoring the original façade, and reversing earlier alterations.

Solution
The architects approached the project as an extension, integrating PV:s into the design. The original qualities of the residential building were restored, while the annex roofs were remodelled with large dormers that integrate solar panels and building-integrated photovoltaics. This strategy allowed renewable energy systems to be added without compromising the refined main façade. The installation covers 95% of the building's energy demand.





Tailored intervention solutions for futureproofing historic buildings

FuturHist aims to develop replicable retrofit solutions for historic buildings of the future. The project ambition is to shift the focus from individual buildings to building typologies and future-proof them for clean energy transition. It will help create a more sustainable and energy-efficient built environment while preserving historic structures.

MORE INFORMATION
Futurhist.eu

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